Air Repair

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In cities and large towns of the Union of South Africa, atmospheric pollution is usually traceable mainly to residential suburbs. This is "wind-still" Pretoria.

AIR POLLUTION CONTROL ASSOCIATION

4400 FIFTH AVENUE **PITTSBURGH 13, PA.**

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Air Repair

A QUARTERLY JOURNAL DEVOTED TO AIR PURIFICATION

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Table of Contents

	Page
Union of South Africa	125
Gray Iron Industry Problems	128
Television in Industry	129
High Stack Statistics	132
Tentative Program—Baltimore Annual Meeting	138
You and the Air You Breathe	140

The Editor welcomes writers interested in Air Pollution problems and encourages them to use the pages of this magazine for the expression of their opinions. But neither he nor the Association assumes responsibility for the validity of these opinions.

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Atmospheric Pollution and Smoke Control in the Union of South Africa

by F. W. QUASS

INTEREST in atmospheric pollution in the Union of South Africa flickered up briefly in the period of 1948 to early 1951, and then died away completely later in 1951. The earlier interest may probably be ascribed to the publication of a number of articles on the subject, which had a bearing on South African conditions and localities. The papers concerned were:

"Darkening Africa: the Problem of the Smoke Nuisance." *S. A. Engineer,* June, 1948; "Tolerance of Atmospheric Pollution Inflicts Injuries on the Community," by Sir George Elliston, *Municipal Affairs,* February, 1950; "Atmospheric Pollution and Smoke Control," by F. W. Quass, *Official Journal of the Department of Commerce and Industries, March, 1950;* "War on Smog," *Industrial Review,* July, 1950; "Eliminating the Smoke Nuisance," *S. A. Engineer,* January, 1951; "The Need for Smoke Abatement," by Sir George Elliston, *Public Health,* January, 1951.

Based on U. S. Survey

The third article ("Atmospheric Pollution and Smoke Control") was based mainly on an excellent survey of the problem of air pollution in the United States of America, and of the methods of control applied in that country, which was drawn up by Mr. D. R. Masson, head of the South African Scientific Liaison Office in Washington, D. C.

With this survey as a basis, an attempt was made to apply some of its findings to conditions prevailing at certain places in the Union, and more particularly in the city of Pretoria. The following cities and towns in the Union and the Rhodesias have populations of approximately 60,000 or more:

*Johannesburg	864,900
Cape Town	427,252
Durban	424,160
Pretoria-Hercules	227,352
East London	91,838
Pietermaritzburg	72,170
Port Elizabeth	152,721
*Springs	115,880
*Germinson	113,765
*Benoni	93,438
*Brakpan	84,114
*Boksburg	64,950
*Krugersdorp	67,000
*Roodepoort-Maraisburg	77,978
Vereeniging	59,669
Bloemfontein	73,800
Kimberley	62,058
Bulawayo	93,850
Salisbury	118,500

*Situated in the reef area proper.

Problem Differs

The problem of atmospheric pollution in the Union differs to a certain extent from that of many places in the United States. Generally we have here hardly any visible pollution in the wet summer months, but during the dry winter months extremely unpleasant conditions can develop.

Large parts of the Rand* are blanketed under a heavy pall during the winter, the dust from the numerous mine dumps naturally adding to the murkiness of the atmosphere. Cape Town, of course, has its white tablecloth of mist in Table Mountain during certain seasons, but in winter the city is often enveloped in a black swathing of dirt and grime. Again on a winter's morning in Pretoria one often has the impression of entering into a dense fog, particularly when approaching the lower-lying central business area from the outlying residential suburbs.

In the United States it has been found that indifference, ignorance and carelessness in connection with combustion processes and inefficient and obsolete combustion apparatus and methods employed by industries are major causes of pollution of the atmosphere. This finding fits the South African picture perfectly.

*Rand: abbreviated from Witwatersrand, an elevated ridge in South Transvaal, South Africa, forming the water-parting between the Vaal river and the Olifants river. The Rand is famous for its auriferous reefs, and the word is often used as a synonym for the extensive gold mining industry of this area, or for Johannesburg, the city which the industry created. It is a Dutch word, meaning rim, edge, ridge of hills.—Encyclopedia Britannica.

Map of South Africa.

Here are South Africa's famed Union Buildings, which dominate the administrative capital, Pretoria, photographed on a clear morning. Note imposing architecture.

General Louis Botha is having a hard time of it on a winter's morning, when the smog lay heavily over the Union Buildings in Pretoria. Botha was the Union's first Prime Minster.

Private Homes to Blame

The domestic consumer of fuel is, of course, by no means blameless in so far as pollution of the air is concerned. Although some American authorities go so far as to assert that 70 to 80 percent of the smoke in the atmosphere at some places is contributed by householders, there are others who think that at other places their contribution amounts to only 5 to 10 percent.

It should be mentioned here, however, that American homes are generally equipped with automatic stokers and that gas and oil are extensively used for heating purposes. Where the common coal stove, the slow combustion stove and open grate, and furthermore "open" fires are used, as in the Union, atmospheric pollution is usually traceable mainly to the residential suburbs of the city.

There is little doubt that the "open" fires favored by non-Europeans, particularly those living in locations on the outskirts of towns and cities, contribute in no small measure toward air pollution in South Africa.

This is consequently the principal reason why the smoke problem in South Africa is greater in winter than in summer, because more coal is then used for domestic purposes, particularly in open grates. From the foregoing it is therefore clear that, in the Union at any rate, the domestic consumer—European and non-European—is the greatest offender.

Coal Shortage

During 1950 the Union enjoyed a mild winter, but during 1951 the coldest winter for a decade was experienced. In the latter year, however, all parts of the Union suffered a highly critical coal shortage owing to the lack of adequate rail transportation to meet the ever-growing demand for coal. The winter of 1952 was again particularly mild. Thus in the past three winters, when cities in South Africa could have developed smog problems, either there was no reason to use larger quantities of coal—or sufficient coal was not available.

A very important factor militating against the introduction of smoke control ordinances in cities of the Union is the cheapness of coal. In the most heavily populated area of the Union, namely Southern Transvaal, which includes Johannesburg, the reef towns, Pretoria and Vereeniging, coal can be obtained for $2.50 and less per ton. This price is comprised of approximately $1.25 per ton pithead price and an equal amount for railage. Thus the attainment of the highest degree of combustion efficiency coupled with fuel economy does not receive attention, a condition which does not tend to promote smoke control. It is therefore extremely difficult to propagate air pollution control in South Africa from the point of view of a reduction in fuel costs and the recovery of valuable by-products.

Burn Smokeless Fuel

A method of smoke prevention very widely applied in the United States is to prohibit the use of coal with a high volatile matter content. Such fuels as anthracite, coke, etc., are comparatively smokeless, and even if they are burned by inefficient methods, little smoke would be produced. This method is particularly applicable in exercising control over domestic consumers, where their large numbers make regular inspection impossible.

In the Union, ironically enough, bituminous coal is used in slow-combustion stoves which are specially designed for the use of anthracite, despite the fact that large deposits of anthracite exist in the province of Natal. High haulage costs counteract a more general use of anthracite in areas in the Union situated near bituminous coal fields.

Locomotives also play their part in air pollution, and this can readily be seen in cities where a large amount of shunting is done. In the United States the use of Diesel locomotives is recommended for marshalling operations. Owing to the cheapness of South African coal it is the policy of the South African railways to use steam locomotives, except along routes where the traffic density permits the employment of electrically powered traction units.

At a congress of the Health Officials' Association of Southern Africa, held in Johannesburg in 1950, it was stated that

The author, who is at present industrial adviser to the United Resources Development Council of the Union of South Africa, retains a lively interest in fuel technological matters, a fact which he ascribes to his very lengthy period of service with the Fuel Research Institute of South Africa. He spent two years (1947 to 1949) in Washington, D.C., as industrial liaison officer to the Department of Commerce and Industries of the Union of South Africa. During this period he travelled extensively in the United states, particularly in search of fuel "know-how."

no matter how desirable an unpolluted atmosphere might be, it was not feasible and it was not in the best interests of the nation to impose conditions which might cripple industry. The symbol for South African industry must therefore remain a factory chimney belching forth thick, black clouds of smoke!

Los Angeles Comparison

Los Angeles is considered to be one of the "black spots" as regards atmospheric pollution in the United States. Unique meteoroligical and typographical features are considered to contribute to its particular pollution problems.

It has been estimated that Los Angeles, which has a population of approximately two million and extensive industries and oil refineries, discharges roughly 822 tons of sulfur dioxide into the air every day. In this city very little coal is used, heat and power being generated mostly by burning oil and gas. Both of the latter fuels, however, also contain small quantities of sulfur.

Let us now proceed to compare these figures with those of Pretoria. Here more than 1.8 million tons of coal, containing from ½ to 2 percent sulfur, are burned annually one way or another, thus liberating upwards of 18,000 tons of sulfur, calculated on an average basis of 1 percent sulfur. This, in turn, will give 36,000 tons of sulfur dioxide gas, which will combine with moisture in the air to form 55,000 tons of sulfuric acid.

In a comparison between Los Angeles, which is more than 450 square miles in extent, and Pretoria, which covers an area of only 70 square miles, we find that approximately 1¾ tons of sulfur dioxide per square mile are liberated above Los Angeles every day, while approximately 1½ tons per square mile per day of the gas, *originating from coal alone*, are formed over Pretoria.

Low Wind Speeds

If Pretoria is to develop industrially to a much larger extent and the conditions of atmospheric pollution increase accordingly, this city may experience extremely unpleasant—possibly disastrous—occurrences of smog during winter months.

Meteorological evidence indicates that for nearly five winter months, April to August, (seasons are reversed below the equator.—Ed.) the average wind speeds from 6 p.m. to 8 p.m. are from two to three miles per hour. Furthermore, "inversion" atmospheric conditions exist in the early morning.

Even today motorists are regularly forced to use their car lights to penetrate the pall of smog which hangs over the city in the early morning. When it is borne in mind that a major contributory factor cited in the Donora, Pennsylvania, disaster was a very low wind speed of less than seven miles per hour, which was taken to be too slow to remove contaminants in the atmosphere, the potential of the "wind-still" city of Pretoria to develop a smog crisis in winter is great.

It has been suggested by medical men that the deleterious effect of the smoke pall which hangs over Pretoria at night on the health of its citizens probably accounts for the comparatively great incidents of diseases of allergy such as asthma, hay fever, and other infections in Pretoria.

Tears flow unrestrained down the cheeks of Doreen Dohmeyer—the result of an eye-smarting fog in Los Angeles during the past winter. Visibility was limited to less than a block.

Overcome Apathy

In 1950 the City Council of Johannesburg, the largest city in Southern Africa, appointed an Advisory Committee to investigate the problem of smoke control. At the very first meeting of this Committee the question was raised: "Does a smog problem actually exist in Johannesburg?"

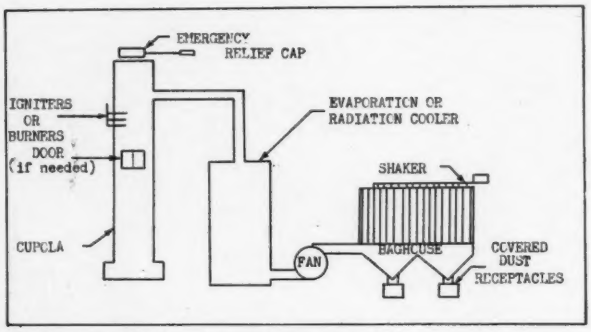
Technologists serving on the Committee then prepared a detailed program of investigation and cost estimate to answer this query. The investigation was summarily dropped by the Council on the grounds that the necessary funds for this survey—only 3,000 pounds $8,400)—were not available. Thus in the most densely populated area of the Union there is no scientific verification that a problem of atmospheric pollution exists!

It was clearly evident that the Fathers of the Golden City were imbued with a spirit of laissez-faire in respect of atmospheric pollution. Only the future can tell whether they have acted wisely.

The apathy of Johannesburg reflects the general attitude of the Union to the problem of atmospheric pollution.

Gray Iron Industry Problems

by PHILIP S. TOW
Investigator, Los Angeles County Air
Pollution Control District



Elements of a baghouse control system applied to a cupola furnace.

THE USE of the cupola furnace by the gray iron industry creates an air pollution problem of increasing concern to many communities. In Los Angeles County two laws apply directly to the operation of these furnaces. One, a provision of the California Health and Safety Code, limits the discharge from any source to three minutes in any hour if such discharge is 40 percent or greater in capacity at the point of discharge to the atmosphere. The other, a rule of the Rules and Regulations of the County Air Pollution Control District, limits discharge to the atmosphere of dusts and fumes to a percentage of the weight of materials charged to a process, such fraction itself being based on the process weight.

On April 5, 1949, the effective date of the Los Angeles County regulation relating to dust and fume emissions, all gray iron melted in the county was poured from cupola furnaces, none of which were operating with effective control devices.

Because of the nature of the cupola operation and regardless of care, all gray iron foundry operators found their losses to the atmosphere to be in excess of the new standards. Most, but not all, of the gray iron foundries also operated in excess of the time-opacity rule.

Tightening Up

The new rule had the effect of being more stringent regarding cupola operations than the time-opacity law but required actual stack tests instead of simple field observations to determine the extent of losses to the atmosphere. The rule also had the effect of giving any foundry operator the opportunity to determine his losses accurately and it was hoped would serve as a basis for more effective design of control equipment. It was felt, in addition, that this stringent rule was necessary to control emissions of very fine particles present in the atmosphere during periods of heavy air pollution.

Foundry owners availed themselves of the right to apply to the Air Pollution Control Hearing Board for temporary variances from the provisions of the statutes involved. The Hearing Board, taking cognizance of the fact that no control devices had been designed for gray iron cupola furnaces which would meet the standards of the new rule, granted variances and continuances of variances for periods adding up to two years.

Further variances have been granted, generally, only for time necessary to install approved control devices. The most recent variances have been granted only for unusual problems involving completion of construction adjustment or testing of control equipment.

Baghouses Satisfactory

From the study and thought originally given to the design of control equipment, the baghouse appears to be the least expensive device that has satisfactory collection efficiency.

Elaborate water-wash devices have been installed on an experimental basis, but none have met the standards. On the basis of previous experience with metallic fume collection, except for the possible exception of the Venturi-type scrubber, the Engineering Division of the District will not grant authorization to construct water-wash type control equipment for cupola furnaces.

At present, the only other successful cupola-control equipment in Los Angeles County is the electrical precipitator. The electrical precipitator represents a very large initial expense, but promises to have an advantage in being easier to maintain in proper working order.

Experiences so far with existing baghouse control units on cupolas shows that the foundry operator must be careful to inspect and maintain the baghouse system regularly and properly. Despite proper care, replacing of bags will be an expense to consider. Other control equipment breakdowns are generally minor. In a few years plant records will undoubtedly give operators close check on depreciation and operating costs of baghouse control systems.

Reverberatory Furnaces

It was evident that whichever of these successful cupola-control devices was considered, the expense would be considerable, and such expense for some small or marginal operators was prohibitive.

Most of these companies which did not have very heavy melting requirements met this challenge by installing gas— or oil-fired reverberatory furnaces which easily met the regulations without control equipment.

Whereas such furnaces had been known to melt gray iron successfully, their use has resulted in what might be called a new way of life for local foundry operators. As might be expected, many operators had difficulty and still have trouble in pouring satisfactory iron and maintaining the furnace in proper working order.

At this time, however, the majority of reverberatory furnace operators are satisfied and some even prefer the reverberatory furnace over the cupola. One disadvantage of the reverberatory furnace is that high carbon iron must be

charged to the furnace and generally as pig so that the carbon content will not be reduced excessively.

The following table indicates the progress of the iron foundry control program as of Feb. 24, 1953. It can be seen that all control installations are completed or under construction at this time:

Gray iron foundries in operation	52
Malleable iron foundries in operation (using cupola furnaces)	2*
Gray iron foundries using reverberatory furnaces	14†
Iron foundries using cupola furnaces	41†
Iron foundries operating approved baghouses	31
Iron foundries operating approved electrical precipitators	1
Iron foundries having baghouses under construction or test	6
Iron foundries having other control systems under construction or test	3‡

*Another malleable iron foundry operates an electric steel furnace.
†One foundry operates both types of furnaces.
‡One is a water-wash system, two are electrical precipitators.

The gray iron industry is, of course, only one factor in the overall air pollution situation in any industrial community. It is hoped, however, that the summary above may serve as a basis of encouragement for any community interested in the control of metallurgical and other dust and fume problems.

Ladies' Program
Baltimore Annual Meeting

Monday, May 25

2:30 to 3 p.m. Board buses at Lord Baltimore Hotel for Harbor Excursion on SS. Bay Belle

3:30 p.m. Maryland Crab Feast aboard Excursion Steamer

Tuesday, May 26

10:30 a.m. Trip to Annapolis and United States Naval Academy, with luncheon at Carvel Hall

Wednesday, May 27

12:30 p.m. Fashion Show and Luncheon at Sheraton-Belvedere Hotel

7:00 p.m. Annual Banquet, Floor Show and Dance—Calvert Ball Room, Lord Baltimore Hotel

Special buses will be furnished to conduct the ladies to Annapolis and the fashion show from the Lord Baltimore Hotel.

Television in Industry

by G. Holmes Wilson
Diamond Power Specialty Corporation
Lancaster, Ohio

HAS TELEVISION a place in industry?

Unquestionably yes. Actually it was first considered as an industrial device, rather than a medium of entertainment, and so it is understandable that television's pioneers look today with some bewilderment on the fact that its use as a technological instrument has been overshadowed by its growth commercially.

Television's commercial development, however, had quite a head start since industrial television, or ITV as it is popularly called, did not come into being until after World War II. The special closed circuit systems which saw action in providing a means of guiding bombs or maneuvering drone planes were direct forerunners of the equipment used industrially today.

Television performs the following basic function in industry:

1. It reduces accidents.
2. It reduces operating costs.
3. It reduces capital investment.
4. Under certain conditions it provides greater intelligence than can be gained by direct observation.

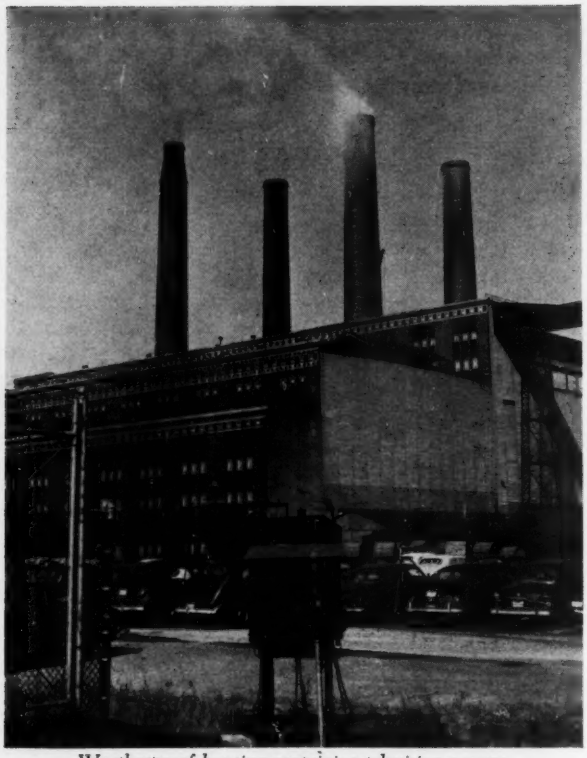
Arguments Pro

The main task in design of industrial television was to find the optimum point of balance between complexity and picture. It was found that, by employing a long life "cold cathode" tube (one without a filament or electron gun) with a consequent slight reduction of picture definition, television equipment could be evolved which would operate independently of supervision, on a continuous basis 24 hours a day; would remain in adjustment once set; would be simple enough for personnel of using organizations to maintain in most instances; would represent an operational and maintenance cost of less than 15 cents per hour based on guarantees which were almost always exceeded, and in many cases, to the extent of reducing this cost to less than a fourth of that figure in actual practice; would maintain its adjustment regardless of temperature variations between 0 and 150 deg. F., and in the face of vibrations far in excess of those encountered industrially under average conditions; would produce a medium definition picture instantaneously and continuously at any distance, the separation between camera and viewer being limited only to necessity of booster amplification when it surpassed 1,500 ft. Moreover, this equipment could be guaranteed under the above conditions for one year.

Equipment

The average type of installation involving industrial television includes a camera viewing an object or process whose position and/or movement can be viewed without need of lens readjustment.

Close by the camera, but as far as 100 ft. away if necessary, is the camera's power supply. At the control position is the



Weatherproof housing containing television camera viewing smoke stacks.

monitor, or viewer as it is sometimes called, receiving picture information by means of coaxial cable.

This is typical of an installation in the power industry where television is employed to transmit water level indication from a gauge at the drum level of a large boiler to the operator's position, the distance of transmission involved being sometimes as much as 250 ft., usually in excess of 100 ft.

The problem of remote vision has plagued industry for a long time. Where line of sight was constructed mirrors were used, but since the size of an object decreased as distance increased, this method had its limitations. It remained for television to bring the subject close to the observer, though he was a considerable distance away.

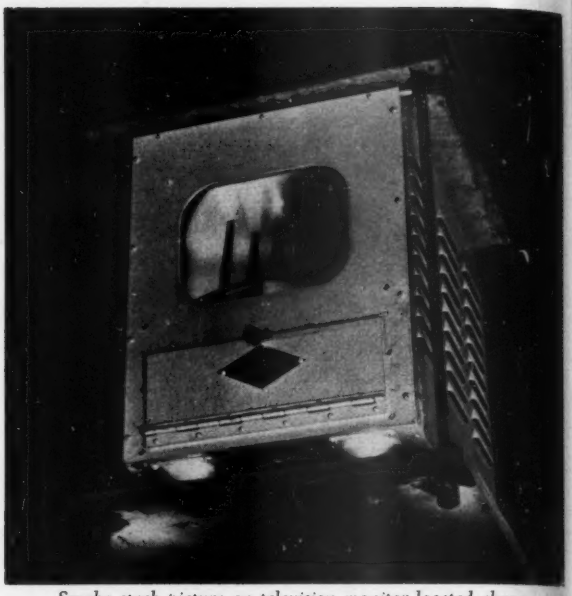
Television not only provides a picture but places in the hands of the operator a *fail-safe* instrument. Unlike remote indicators, it can never provide a wrong answer—an advantage of paramount importance.

Smoke Observations

One of the most interesting uses of television in the power industry is for smoke stack observation. The first installation of this type was made at a plant near Chicago.

Realizing that the public was becoming ever more acutely aware of the "smoke nuisance," this utility decided to take progressive measures in keeping smoke discharges at a minimum by making it possible for the boiler operators deep within the station to see during the day just how much or how little smoke was being discharged.

It was felt that, were the operators to see instantly what



Smoke stack picture on television monitor located above firing aisle within power plant.

was happening, they could more quickly correct any furnace condition which was causing undesirable smoke emanation. Furthermore, they felt that an instantaneous TV picture would present the story more effectively than a meter needle.

Installation was made in January, 1951. After a successful demonstration had proved the validity of the application, the camera and its associated power unit were located an appropriate distance away from the station's four stacks and enclosed in a simple weatherproof housing. Coaxial cable was run under ground to the private viewers, or monitors, located above each of two firing aisles, with the plant approximately 450 ft. away.

Automatic Auxiliaries

Choice of camera location was influenced by the amount of area that had to be viewed and the need for pointing the camera in a northerly direction so that it would not be possible for the sun to shine into the camera lens and be focused on the camera tube, thus damaging its surface.

While the camera could withstand much more rigorous conditions than the usual type of television camera, provisions were made to automatically switch on forced ventilation if the temperature within the housing exceeded 150 deg. F.

To prevent frosting of the lens in winter time, a heater was installed to operate automatically whenever the mercury dropped below zero. To check weather limitations further, a windshield wiper was included which could be operated remotely during rain or snowfall. To make sure the housing's observation window stays clear during winter storms, a remotely controlled window defroster was added.

Although television and accessory equipment cost of about $4,500 is much greater than that of other smoke detectors, the fact that only one piece of equipment was required for all stacks, brings the cost per stack to a figure comparable with conventional instrumentation, especially when one considers that much less maintenance is required.

Television camera in air-cooled housing viewing the pouring of a continuous billet.

Remote Control

One of the first applications to be made outside the power plant involved the remote observation of high explosives which were undergoing machining operations. Once this application became established at a government arsenal in the Midwest, similar problems at other government installations were solved in a like manner.

Although the process to be viewed varied in most instances, the same purpose was served. Later installations included equipment for remotely observing bomb dis-assembly at Picatinny Arsenal; similar equipment viewed hazardous devices on test at Aberdeen Proving Ground, as well as at the U. S. Naval Ordnance Test Station, Inyokern, Calif. An installation was recently made at Watertown Arsenal to safeguard observers watching numerous types of destructive tests where the possibility of an explosion was ever present.

At Babcock & Wilcox Tube Co., Beaver Falls, Pa., control of a continuous billet pouring process was centralized in the hands of one man who formerly had to rely on hand signals

Control operator viewing mold pouring picture on monitor built into control console.

from an assistant at the mold entrance who was subjected to unfavorable working conditions. Accompanying photographs show the camera location directly over the pour, and the observing position with the monitor built-in to the control console.

At Geneva Steel Company in Utah, television now enables a control operator to be visually in four places at one time. Previously, he relied on the verbal instructions or hand signals of men stationed at the entrances of several re-heat furnaces so that steel slabs could be properly positioned in front of the respective entrances, thus eliminating the possibility of misaligned slabs damaging the furnaces when forcibly pushed into the entrances of mechanical means which the central operator controlled.

A job of furnace viewing quite different from the usual is being employed by the Timken Roller Bearing Company, Canton, O. A control operator views tubes at a cooling furnace entrance so that "pile-ups," which might impair the control of uniform heat loss, can be eliminated without the necessity of stationing an extra man at the furnace entrance. The distance between the camera and monitor is approximately 100 ft., making image transmission by the use of mirrors unsatisfactory.

Be Sure To Be At

B A L T I M O R E

May 25 - 28, 1953

LORD BALTIMORE HOTEL

See Tentative Program—Pages 129 and 138-39

46th ANNUAL MEETING—AIR POLLUTION CONTROL ASSOCIATION

Anticipating and Preparing Against Possible Industrial Hazards from Air Pollution*

by GEORGE R. HILL

WHEN THE INVITATION to address this conference was received, there came with it this request: "Would you speak on a hypothetical situation, assuming that you are reporting the results of an investigation, along with the recommendations arising from your findings, which you have made for a company having plans to build and operate a plant in the heart of a rich agricultural district where horticultural and dairying activities are carried out?

"The plant operations will give rise to gases and fumes which are to be dispersed by high stacks and/or collected and removed by proper engineering methods. However, the gases and fumes are known to be potentially harmful, both to foliage and livestock grazing on forage contaminated by such effluent.

"Your investigations in the area have covered topography, meteorology, plant and animal pathology. Your findings, both in plants and animals, reveal lesions that are similar to those known to be caused by the gases and fumes to be generated in the plant operations at a later date.

"Your method of recording the appearance of vegetation at intervals by aerial photographs in color and showing stack exhaust above an inversion would be of special interest to the audience."

This is a comprehensive order and at the same time an intriguing and challenging one. What industry would not like to know the hazards from operating a plant that of necessity must produce certain effluents which would constitute a nuisance and might be injurious to plant and animal life?

Minimize Hazards

What factors should be considered in the location, construction and operation of such a plant in order to minimize these hazards to the greatest degree? Is it true that there may be discolorations on the leaves of plants, quite unrelated to air-borne effluents, which a farmer would be likely to attribute to the smoke from a manufacturing plant? How could such complaints be satisfactorily answered? Assuming that emanations from a certain plant occur in concentrations productive of injury, can the farmers be compensated therefor to the mutual satisfaction of both parties, thus maintaining good will and avoiding expensive litigation or agitation for remedial legislation following such occasional occurrences? What are air pollution hazards, and how do they become such?

Since the physical laws relating to the dispersion of sulfur dioxide apply to all other gases as well as to liquids and solids which are fine enough to be relatively unaffected by gravity, it might be well to consider historically the problem of air pollution control as related to fumes and sulfur dioxide. Probably no other industry has been through such bitter litigation as the non-ferrous smelting industry. Smelters in large numbers have been enjoined and closed down by the courts over effluents—mostly solids.

Salt Lake City smoke blanket taken January 25, 1947 looking east. Note three strata of smoke, each distinguished from the one above it by color plus a stratum of more or less smoke-free air from 200 to 500 feet thick. See thin ribbon of white smoke from 450 feet Murray stack rising diagonally 300 to 400 feet to a stratum of equal air density, after which it drifts to the left past the edge of the photograph as a thin horizontal ribbon of smoke.

Satisfactory Treatment

The satisfactory treatment of smoke to remove the solids came about with the baghouse and a very few years later by the electrostatic precipitator called a Cottrell plant. Both the baghouse and the Cottrell are capable of 98 to 99% clearance in the removal of solids. Gases go through each undiminished.

Shortly after the turn of the century, metallurgists found that the metals from metallic sulfide ores could be recovered if the sulfur they contained could first be roasted off. This discovery, coupled with the discovery that these metallic sulfides could be concentrated from less than 1% in ores, to high grade concentrates, by a stirring agitation of the finely-ground ore-water mixture with a small quantity of certain non-soluble substances, causing the mixture to foam and carry off as part of the foam, the valuable metals, has revolutionized the mining and smelting industry in the last generation.

It added a very perplexing problem—what to do with the sulfur dioxide produced by roasting these sulfide concentrates? When that gas reaches the ground in concentrations higher than one part per million, it becomes offensive to many people and, if it persists for an hour's time, can mark sensitive vegetation.

* From an article appearing in the June, 1952 issue of the American Industrial Hygiene Association *Quarterly*. Presented at the Air Pollution Abatement Conference, Manufacturing Chemists' Association, Hotel Statler, New York City, February 25-26, 1952.

Smelters Threatened

In 1916 the Murray and Midvale smelters were enjoined from operating, unless they could do so without the occurrence of concentrations of sulfur dioxide which would damage crops. They were given four years in which to make the necessary studies and effect remedial measures.

O'Gara, Fleming and Jones found that, although the sulfur dioxide was remarkably uniform in concentration and amount as it left the stack, that ground concentrations were anything but uniform. It was too dilute to be smelled or mark crops most of the time.

Under certain weather conditions, however, ground concentrations were distressingly high. They found, from some tens of thousands of analyses, that the high peak of average concentration occurred, not at the stack, but a few stack lengths away, following which it decreased rather rapidly as distance from the stack increased.

They measured these concentrations while the smelter was operating with a stack 200 feet high, then 300 feet high, and finally with one 450 feet high. They found a great decrease in ground concentration as height of stack increased.

They thought to reduce the concentration in the stack still more by blowing three volumes of air into the stack for each volume of smoke. This further lowered ground concentrations, except following periods of dead calm.

After one of these dead calms, lasting hours, they had the worst burn in Murray's history. The large diluter fan, which cooled the smoke as it diluted it, was immediately abandoned and a large coal burner was installed at the base of the stack to heat the smoke to greater buoyancy. This practice greatly decreased ground concentration, even during the following dead calms.

During such periods of very low wind velocity the smoke rises until it encounters air of equal density. Then it mushrooms out laterally in all directions until dispersed by wind of sufficient velocity. The height to which it will rise before thus mushrooming will depend upon its temperature. When that is the same as the surrounding air temperature it cannot rise beyond stack height unless forced out of the stack at great velocity.

Dr. O'Gara concluded that each degree Fahrenheit of rise in stack temperature was the equivalent of 2½ feet of added stack height.

Upwards of 95% of complaints of sulfur dioxide of high concentration from reasonably high stacks, occur during or immediately following prolonged calms. With short stacks, complaints may often occur in addition, whenever the smoke blows toward the complainant.

Note dense smoke blanket about 300 feet thick, separated from horizonal smoke ribbon by a stratum of smoke-free air 400 to 500 feet thick.

Trouble Ahead

The Selby Smelter found itself in difficulty with a new and rapidly-growing town about a mile farther up the Carquinez Straits. During the growing season the wind blows east up these Straits the major portion of the time. The smelter stack was only 146 feet high. Selby found it necessary to go to great expense for stack heating, and even then found it necessary drastically to curtail roasting operations, frequently hours daily, to avoid complaints from these new residential areas. This greatly increased the cost of treating ores.

Selby had long debated the construction of a tall stack. The smelter was located at water's edge in a half-mile-wide gorge. Hills several hundred feet high were on each side. The new housing extended to the very top of some of these hills. Might not a tall stack make matters worse by lifting the smoke to the same height as some of this housing before releasing it? How could one be reasonably certain?

Two standard wind vanes, one located on a hill at the height of the 146-foot stack, the other on a hill nearby 387 feet high, gave average wind directions differing by 45° from each other two-thirds of the time. Two toy balloons, one filled with an air-hydrogen mixture to air buoyancy and the other with hydrogen alone, were fastened together by a fuse string of such length that it would free the balloons at any desired height. The direction each balloon took was then charted by means of theodolites.

After half a minute the direction of these balloons differed by 15° to 45°. The ground smoke frequently took still a different direction. This indicated that smoke eliminated above 500 feet would be fanned out before reaching the ground again, as much as 15° to 45° in addition to the dilution due to stack height. This was confirmed by the observations of smoke ribbons laid down about 600 to 1,000 feet above the water in the Carquinez Straits and photographed at a few second intervals as they looped up and down and horizontally.

High Stacks Solve Problem

The new Selby stack, 605 feet high, went into operation October 7, 1937. It solved the sulfur dioxide problem completely. The ensuing 15 months there was recorded on a Thomas SO_2 autometer, located on Dillon Point, 2.6 miles easterly up the Carquinez Straits, an amount of sulfur dioxide exceeding 0.5 ppm for a half-hour period, only once, and then it was only 0.52 ppm. For the preceding 42 months, from the 146-foot stack, in curtailed operations during critical times, an amount of SO_2 in excess of 0.5 ppm for a half-

Photo, taken February 11, 1947 facing east, shows a dense smoke blanket completely obscuring the base of stack; a less dense grayer stratum about stack top level, and the white plume of smoke passing diagonally upward about 500 feet, when it apparently reaches the top of the inversion layer and is thence quickly sucked up into the vast reservoir of the upper air and is rather quickly dispersed.

hour period, had been recorded 842 times. The average concentration during these 842 occurrences above 0.5 ppm was 0.72 ppm. The average concentration from the short stack during the preceding 42 months was 0.057 ppm. The average concentration from the tall stack was 0.025 ppm. During 1008 half-hour periods while the Selby plant was not operating, it was 0.013 ppm. This tremendous success in air pollution control was achieved by raising the stack height from 146 to 605 feet.

English Reports

About this time Bosanquet and Pearson published in the Faraday Society reports, a theoretical equation based on voluminous studies of smoke from chimneys of different heights in England, which in substance said this: The concentration of an effluent reaching the ground from a chimney varies inversely as the square of chimney height; the peak of concentration occurs about 10 chimney lengths from the base of the chimney; reduction in concentration extends some 50 chimney lengths, following which the concentration varies inversely as the square of the distance from the source. This would mean that the concentration from the 146-foot Selby stack should be about 16 times as great as the concentration from the 605-foot stack.

The performance of the tall Selby stack has been far better than this 16 to 1 ratio in preventing high peaks of concentration—this probably as a result of the spreading effect due to the differences in direction of the wind at different elevations. No complaints have come since the tall stack was cut in. Stack heating has been unnecessary. No curtailment during critical weather has resulted in greater efficiency of operation.

Often the smoke from the tall Selby stack can be seen blowing in one direction and the ground smoke blowing in another. It was this abundantly-demonstrated fact, coupled with the known effectiveness of tall stacks, that finally convinced the American Smelting and Refining Company officials that a high stack would probably solve the difficulties in this difficult terrain.

Turbulence, an almost constant characteristic of wind, blowing from high to quite a low velocity, enables the wind adequately to disperse gases, once they are carried high enough into the air as not to be blown immediately to the ground again. The significance of this property of wind is often very little appreciated by construction engineers who plan manufacturing plants. This characteristic, turbulence, is that restless tendency of wind to shift in direction horizontally and vertically from some 45° to more than 90°, 50 to 150 times an hour.

At about 25 miles an hour the wind vane makes some 150 swings back and forth per hour through an amplitude of some 45°. At five to eight miles per hour the number of these swings is reduced to some 50 per hour, but the amplitude of swing is much greater, occasionally reaching 180°. When the velocity drops below three miles an hour, instead of the 50 or more swings, these swings virtually cease and smoke piles up. At such times, facilities for carrying the liberated smoke high and hot to the inexhaustible reservoir of the upper air is a good means of preventing annoying ground concentrations.

No Rhythm in Calms

Most calms giving rise to complaints occur when the wind velocity is so low as to be without the spreading effects of these rhythmic swings. Only a fraction of such calms, however, when high stacks are employed to effect dispersion, are accompanied by annoying ground concentrations. Since the tall Murray stack demonstrated the principle, many other smelters have adopted the same means of overcoming air pollution hazards.

That the upper air has tremendous power to swallow up air pollution is further seen in the fact that St. Louis, Chicago, and Pittsburgh throw into the air enough sulfur daily, to give a sulfur dioxide concentration of one part per million throughout an area of 30 miles radius to a depth of a quarter of a mile. Yet in studies made in these cities during the winter months, when concentrations are the highest, one part per million was rarely encountered. The average for St. Louis was 0.147 ppm, and for Pittsburgh 0.064 ppm. Figures were not available for the Chicago average.

Wind direction and velocity may now be recorded directly on the same recorder roll on which the sulfur dioxide record is made. Such recordings furnish an excellent means of quickly correlating wind direction and velocity with concentrations of sulfur dioxide at ground level.

Knowing Calms Important

A knowledge of the frequency and duration of calms is indispensable to a proper appraisal of hazards from plant operation. A method of forecasting the occurrence of calms of over three hours' duration would be invaluable. Then an operator might so stagger his operations as largely to avoid creating a nuisance. Prolonged calms are not of very great frequency in most places.

A study of the frequency and duration of calms for the Central New Jersey area revealed that while prolonged calms were recorded, they were of rare occurrence. For example, one of 11 hours and two of seven hours each, occurred in 1928. At Salt Lake City in 1928 they were about 10 times as frequent. Periods of similarly low wind velocity were recorded at Trenton and at Sandy Hook in 1928, beginning and ending at almost the same hour as New York. These three prolonged calms in 1928 indicated that such calms sometimes cover considerable territory.

An intensive study of air pollution problems at a score of smelters for a period of more than 25 years has revealed the fact that no two smelters have the same problems. Rarely are the problems of a given smelter alike any two years. Yet a rather uniform elimination of sulfur dioxide from similar roasting operations occurs at all of them. This would indicate that air pollution problems are peculiarly local problems.

Their extremely local nature may be explained on the basis of differences in topography, differences in local meteorology, differences in the frequency, duration, structure, and nature of calms and temperature inversions, differences in the variability of winds, and differences in the industrial location and set-up. How foolish it would be, how lacking in knowledge of the idiosyncrasies of temperature inversions, all different because of differences in these factors, to assume that they could be controlled equitably by a statewide or nationwide law!

Statewide Laws Unwise

The rainfall on Diamond Head on the Island of Oahu is a scant nine inches a year. On the Pali above Honolulu, about ten miles from Diamond Head, it is more than 300 inches a year. A storm sewer law applicable to the entire island would be ludicrous. The equally irregular distribution of masses of calm air determine the extent, frequency, and intensity of air pollution for any given community. How similarly inequitable would be a statewide law to regulate these widely differing problems!

It is not with average concentrations, but peak concentrations occurring once in a "blue moon," then at times of low wind velocity and frequent temperature inversions, that complaints come.

Let us consider temperature inversions. These, for example, are entirely unlike at Los Angeles, at Salt Lake, and in the Columbia River Valley below Trail, British Columbia. In this latter region a zone of little turbulence catches the sulfur dioxide from the Trail smelter and channels it in a thin layer a thousand feet above the river in this half-mile deep gorge, slowly down the river during night and early morning hours. From about 11:00 a.m. till night-fall it similarly channels it up the river. When the morning sun warms up the air on the west side of this canyon, it causes the warmed air to rise and the colder air on the east side of the canyon to fall, resulting in a simultaneous fumigation from Trail to Evans, 40 miles farther down the river.

At Los Angeles a temperature inversion comes in apparently from a non-turbulent mass of warm air over the ocean and reaches the mountains beyond Los Angeles and Pasadena in the late morning hours, covering the Los Angeles basin like a lid. The inversion layer begins 300 to 1,000 feet above the ground and extends upwards some 1,000 to 2,500 feet.

Photo taken at mouth of Parley's Canyon on Highway 40, March 15, 1948. Dense black smoke blanket completely obscures beautiful Salt Lake City. The tiny white streak in the upper central part of the black smoke blanket one-third of the distance from the left side of the photo is white smoke from the Murray stack which rises completely through the smoke blanket and about 300 feet beyond, when it quickly vanishes presumably because it has reached the top of the temperature inversion layer.

Inversions

A third type of temperature inversion occurs in the eastern part of the Salt Lake Valley. This is strictly of local origin. It extends from the ground upward to a height of a thousand feet or more. It is of very frequent occurrence. It usually begins near sundown by the more rapid radiation of heat from the surface of the ground than from the air above it, whenever the sky is clear and there is too little wind to mix the air.

For the past ten years the Department of Agricultural Research of the American Smelting and Refining Company has been measuring this by means of recording thermometers on the KDYL radio tower, one at 385 feet above the ground, one at 15 feet, and two between. Wind velocity is measured at the laboratory a quarter of a mile southeast.

During the winters of 1946-47-48 many Kodachrome panoramic pictures were taken about sunrise on 132 different days from a bench in the central part of the 15-mile-wide valley, where there is usually enough wind to prevent the formation of inversion layers. These show this imprisoned smoke blanket and the mountains above it standing out sharp and clear.

These pictures show a typical smoke blanket extending along the base of the Wasatch Mountains to the northeast, east, and southeast. The Murray and Midvale 450-foot stacks, frequently reaching above the smoke blanket, can be seen. To the southwest, west, and northwest, the Oquirrh Mountains can be seen with clear air extending to the very base.

An interesting feature of these smoke blankets is the fact that they are stratified. The lowest is a stratum of black smoke at housetop level from 50,000 homes burning soft coal. Before Diesels replaced coal-burning locomotives, this smoke also was in this low black stratum. Next is seen a stratum of dark gray smoke about 200 to 500 feet above the ground, from short industrial smoke stacks. Occasionally a third stratum, a thin horizontal ribbon of whitish smoke at about 1,000 feet above the ground, is seen. This can be seen rising diagonally several hundred feet from the Murray and Midvale 450-foot smoke stacks, and then flattening out when a stratum of equal air density has been reached.

Other pictures show beautiful Salt Lake City, taken a quarter mile south of the mouth of Parley's Canyon on Highway 40, completely hidden in a cloud of dense black smoke. To the southwest, that whitish vertically-rising column of smoke is from the Murray stack. It rises for several hundred feet through the black smoke blanket which has completely obscured the Murray smoke stack, and then vanishes, presumably because it has reached the top of the inversion layer.

Interesting Photos

A picture was taken about 20 minutes later, six miles west and three miles south of the preceding one. It shows the same Murray stream rising from the smelter stack and rising some 800 feet to disappear as it did in the preceding picture. The entire smoke cloud vanished about one and a half hours after these pictures were taken, when the sun had overcome the temperature inversion, releasing the imprisoned smoke. This was rather quickly sucked up into the vast reservoir of the upper air as by a magnetic sponge.

The temperature at the 385-foot tower station frequently reaches 15-25°F. above ground temperature from 2:00 a.m. to 6:00 a.m. It was 3° above at 8:30 a.m. when this last picture was taken.

We have much less exact information about temperature inversions and their idiosyncrasies than about any other weather factor. We cannot hope to achieve economic air pollution control without exact knowledge concerning them. Recording thermometers are not prohibitively costly. Tall radio towers dot the landscape. The temperatures can be automatically recorded every minute on the revolving chart of a recorder. This roll of paper lasts 40 days. A brief half-hour visit once in ten days by even a high school physics student to service the recorders and to see that the rolls of recorder paper are renewed when necessary, would give a record by which any community could analyze this type of acute air pollution problems. Then hopefully a method could be devised for taking advantage of this information to the advantage of both industry and community.

Radiosondes Used

To measure the characteristics of temperature inversions beginning 500 or more feet above the ground, it should be possible to attach radiosondes to the cord by which a captive balloon is attached, every 250 feet as the balloon is reeled out. This might give a continuous automatic record, to the height of half a mile, of the beginning, height, gradient, duration, and other characteristics of an inversion. The captive balloon might also be automatically reeled in when the wind reaches any certain velocity, thus preventing loss or damage to the equipment.

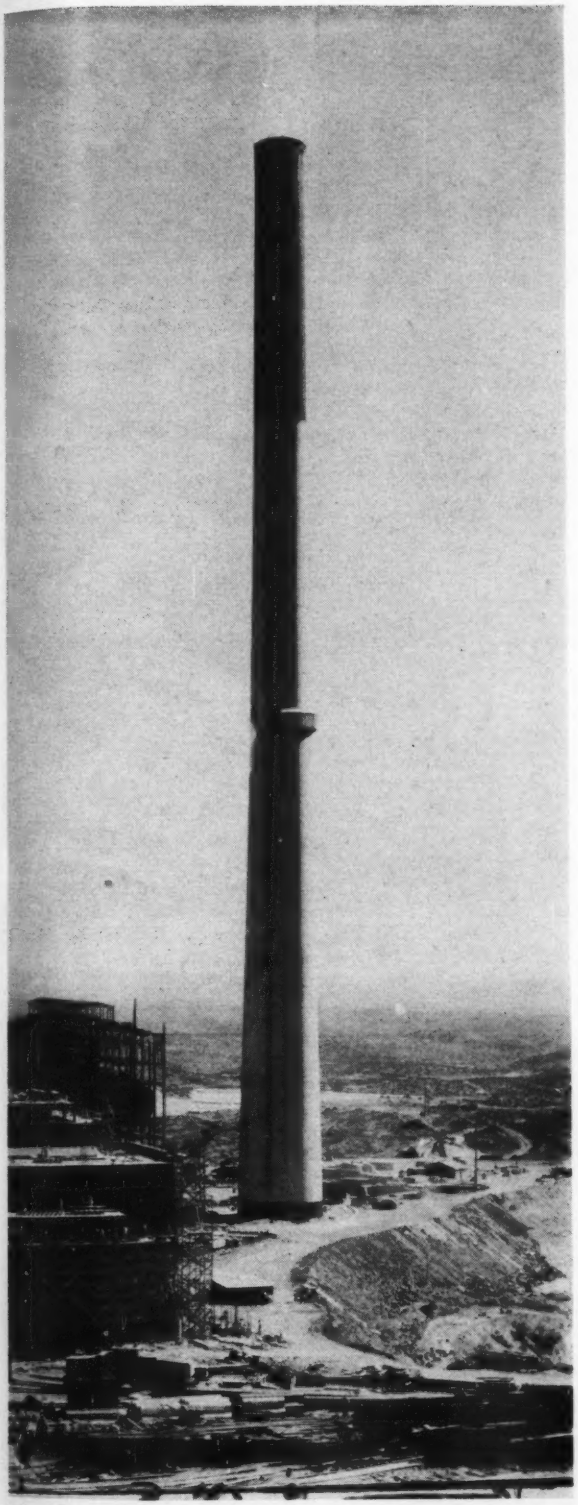
A strong department of public relations has been found by certain companies to be of tremendous importance in dealing with farmers and the public in general, particularly following a weather accident resulting in an annoying fumigation. Farmers in general are the finest of open-minded people. They do not want their crops to be damaged nor has industry the right to damage them. Such damages, when they do occur, can be estimated by a skilled appraiser and paid for to the mutual satisfaction of the company and the farmers by a good public relations man who also knows crops, their diseases and pests, and the characteristics of smoke damage to them. One company, with many plants in this and other countries, has not had a single agricultural lawsuit in more than 25 years by following this policy. To ignore such fumigations or treat them as acts of God, for which the industry is not responsible, is one of the surest ways of bringing on litigation, to be followed by demands for drastic legislation. In the bitter emotions aroused by such a fight, balance of convenience between industry and the community it serves may be entirely lost sight of.

Other Causes Noted

Very often markings due to a myriad of other causes are discovered by a farmer, who believes that they are caused by smoke. This constitutes a real hazard to industry. If the farmer cannot be shown and convinced of the real cause he will fight as hard as though smoke were the cause.

An alert crop inspector will soon recognize that crops vary widely in their susceptibility to sulfur dioxide or other gaseous injury. Before drawing conclusions he will seek the confirming evidence from equally susceptible plants. Not infrequently a crop inspector, and often a farmer, has jumped to the conclusion that a bad case of "white-spot" discoloration on alfalfa was caused by sulfur dioxide. An exposure to sulfur dioxide of an intensity conspicuously to discolor alfalfa, will likewise mark other susceptible crops and weeds. A competent inspector will make frequent inspections in areas far removed to make doubly sure on this point. Often he will be able to set the farmer's mind at ease by taking him to see such crops.

The leaves of plants are temporary structures, specialized quickly to absorb carbon dioxide from the atmosphere and in the presence of sunlight to manufacture carbohydrates therefrom. To this end leaves are exceedingly porous. The waterproofed epidermis is underlaid by a very loose meshwork of connecting cells and large intercellular spaces. These spaces are much more abundant between the veins of leaves than along the veins, because the veins must also serve the leaf as conductors and for strength. The interior of leaves has from 15 to 50 times the area of the surface of the leaf, and this surface is always moist to facilitate the absorption of gases.



This 600-ft. reinforced concrete chimney towers above its Arizona landscape. It is one of the more than 2,500 chimneys designed and erected by the Rust Engineering Company, Pittsburgh, and is rated among the largest in the world.

Sulfur Dioxide Problems

Solids and liquids are excluded from the interior of leaves by the stomata. All gases are equally free to enter. Sulfur dioxide, 30 times as soluble in water as carbon dioxide, is absorbed with avidity. It is absorbed most rapidly in the most porous parts of these fully-grown highly-functional leaves. A collapse of those cells most exposed takes place whenever too much has been absorbed. These cells die and bleach. This leaves a distinctive pattern by which sulfur dioxide markings can usually be differentiated from those produced by other causes.

The less porous parts of plants—the buds, flowers, stems, and fruits—are rarely marked by sulfur dioxide at all, and not unless the fumigation has been sufficiently severe entirely to defoliate the plant.

The leaves of some species of plants absorb sulfur dioxide from a given fumigation several times more rapidly than the leaves of other species. Such plants are called "SO_2 sensitive" as distinguished from the slow absorbers which are called "SO_2 resistant."

Alfalfa, barley, rye, wheat, oats, cotton, peas, lettuce, squash, cosmos, ragweeds, and sunflowers are all SO_2 sensitive. Apples, pears, grapes, sugar beets, potatoes, and tomatoes are intermediate. Corn, peaches, apricots, celery, cucumbers and cantaloupes are SO_2 resistant crops. The order is not the same for other gases. Corn and apricots are among the most sensitive to fluorine, but very resistant to sulfur dioxide. Gladiolus is very sensitive to fluorine, but is intermediate in SO_2 sensitivity.

Discoloration

Because of their ready absorption, water soluble gases quickly accumulate in the leaves of plants until a leaf may contain many times the original content of that substance. When the exposure is over the gases rather quickly disappear, some going back into the air again, but mostly they are fixed in the leaf by calcium or other bases. In the case of sulfur dioxide, it is quickly oxidized to the 34 times less toxic sulfate and is used by the plant in its nutrition.

Attention was called in this paper to a great variety of leaf discolorations due to virus diseases, fungous diseases, mineral deficiency symptoms, and weather effects, all unrelated to industrial effluents, which are nevertheless mistaken by farmers for smoke markings.

Such discolorations on alfalfa, cotton, corn, peach, cherry, plum, and apricot leaves were copiously illustrated with Kodachrome slides. Attention was called to a court injunction against, and the dismantling of, a brick kiln in Canada, because of alleged injury to a peach orchard by smoke from the brick kiln. The following year the discolorations on the peach leaves worsened and were diagnosed as being caused by the Western X-virus disease.

If you were to construct a new plant from which complaints conceivably could come in the future, Kodachrome aerial pictures might show what fields and orchards looked like before you began operating. Such pictures save endless disputes at the close of the season or at a later time.

Tentative Program of the Annual Meeting

Lord Baltimore Hotel, Baltimore, Md. — May 25 to 28, 1953

Monday Morning, May 25

CONTROL OFFICIALS' SESSION—9:30 a.m.

H. K. KUGEL, Chairman; MILTON REIZENSTEIN, Vice Chairman

ROUND TABLE DISCUSSION ON DUST EMISSION CONTROL PROBLEMS

HERBERT JOHNSON, Assistant Smoke Regulation Engineer, Columbus, O. — *Controlling Field Tests to Determine Fly Ash Emission from Stacks*
CHARLES W. GRUBER, Chief Smoke Inspector, Cincinnati, O. — *Locating the Offender*
RICHARD B. ENGDAHL, Battelle Memorial Institute, Columbus, O. — *The Role of the Area Survey*
SAMUEL RADNER, Assistant Smoke Abatement Engineer, Chicago, Ill. — *The Use of Sprays to Reduce Stack Emission*
G. A. MAU, Vice President, The Johnson-March Corporation, Philadelphia, Pa. — *The Elimination of Dust from Asphalt Plants*

INSTRUMENTATION IN AIR POLLUTION MEASUREMENT AND CONTROL—9:30 a.m. (concurrent)

G. A. PERLEY, Chairman; MORRIS KATZ, Vice Chairman

W. B. HARRIS, U. S. Atomic Energy Commission, Ansonia Station, N. Y. — *Equipment for Measuring Radioactive Atmospheric Contamination*
DAVID SINCLAIR, Johns Manville Research Laboratory, Manville, N. J. — *Light Scattering Instruments as an Aid in Air Pollution Measurements*
MOYER D. THOMAS and J. O. IVIE, American Smelting and Refining Company, Salt Lake City, Utah — *Wind Direction and Velocity Instrumentation for Air Pollution Diagnosis*
C. W. MARYNAWSKI and F. E. LITTMAN, Stanford Research Institute, Stanford, Calif. — *A Continuous Recording Visibility Meter for Air Pollution Studies*

Monday Noon, May 25

LUNCHEON

Address of Welcome, HON. THOMAS D'ALESANDRO, Mayor of Balitmore
Keynote address by STANLEY STOKES, Vice President, Union Electric Company, St. Louis, Mo. — *Free Enterprise and Air Pollution Control*

Monday Afternoon, May 25

HARBOR INSPECTION TRIP AND CRAB FEAST ON BOARD LUXURY EXCURSION BOAT S.S. BAY BELLE

Tuesday Morning, May 26

RAILROAD SESSION—9:30 a.m.

S. E. BACK, Chairman; M. G. STEWART, Vice Chairman

GEORGE B. CURTIS, R. F. of E., Richmond, Fredericksburg & Potomac R. R. — *What Railroad Management Is Doing for Air Pollution Control*
THOMAS J. WELLS, Superintendent of Locomotive Operations, Cincinnati, O. — *Trouble and Remedies of Air Pollution Control*
R. L. PALSGROVE, R. F. of E., Reading Co., Philadelphia, Pa. — *Methods of Education for Air Pollution Control*
G. W. MEREDITH, Assistant Master Mechanic, Norfolk & Western Rwy., Bluefield, W. Va. — *Performance of Coal-Burning Steam Locomotives*

CHEMICAL INDUSTRY SESSION—9:30 a.m. (concurrent)

E. N. HELMERS, E. I. du Pont de Nemours & Co., Wilmington, Del., Chairman
A. B. PETTIT, Davison Chemical Co., Baltimore, Md., Vice Chairman

L. C. PALMER and GEORGE E. BEST, Mutual Chemical Company of America, Baltimore, Md. — *Atmospheric Pollution Control in a Chromium Chemicals Plant*
B. K. TREMAINE, E. I. du Pont de Nemours & Co., Wilmington, Del. — *Masking Industrial Malodors*
N. W. CLAUSS, Union Carbide & Carbon Chemical Division, South Charleston, W. Va. — *The Reduction of Atmospheric Pollution from Sulfuric Acid Recovery Processes*
WALKER PENFIELD or W. F. MITCHELL, Pennsylvania Salt Manufacturing Co., Philadelphia, Pa. — *Management Considers Air Pollution*

Tuesday Afternoon, May 26

SYMPOSIUM ON RECENT RESEARCH AND DEVELOPMENTS IN DUST COLLECTORS—2 p.m.

ERIC WALKER, Pennsylvania State College, Chairman; D. L. DEVRIES, Koppers Company, Vice Chairman

EDWARD SALNER, Manager, Elex Precipitator Dept., Koppers Company, Baltimore, Md. — *A Study of Gas Distribution in Electrostatic Precipitators*
H. J. WHITE, Director of Research, Research Corporation, Bound Brook, N. J. — *Electrical Resistivity of Fly Ash*
E. H. R. PEGG, Vice President, and D. W. GIBBS, Engineering Department, Aerotec Corporation — *Internal Flow Problems in Mechanical-Centrifugal Dust Collectors*
WESTERN PRECIPITATION CORPORATION—Subject not yet given
MACK GORDON, Aerodyne Development Corporation — *Engineering and Economic Approach to Foundry Dust Collection*

GENERAL TECHNICAL SESSION—2 p.m. (concurrent)

J. S. SHARRAH, Chief, Division of Air Pollution Control, Pennsylvania Department of Health, Chairman

W. C. L. HEMEON, Director of Engineering, Industrial Hygiene Foundation, Pittsburgh, Pa. — *Use, Evaluation and Interpretation of the Filter Paper Samples*
RICHARD C. COREY, U. S. Bureau of Mines, Pittsburgh, Pa. — *Experimental Work on Incinerators for the Atomic Energy Commission*
J. W. FEHNEL, Republic Steel Corporation — *The Industrial Health, Atmospheric and Stream Pollution at the Republic Steel Corporation*

Tuesday Evening, May 26

RAILROAD DINNER—Closed Session—6:30 p.m.

INFORMAL CLOSED SESSION OF CONTROL OFFICIALS—8 p.m.

BEN LINSKY, Bureau of Smoke Inspection and Abatement, Detroit, Mich., Chairman

Wednesday Morning, May 27

PETROLEUM INDUSTRY SESSION—9:30 a.m.

L. C. BURROUGHS, Shell Oil Company, New York, N. Y., Chairman

VANCE N. JENKINS, Union Oil Company, Los Angeles, Calif. — *The Petroleum Industry Sponsors Air Pollution Research*

FRED E. LITTMAN and PAUL L. MAGILL, Stanford Research Institute, Stanford, Calif. — *Some Unique Aspects of Air Pollution in Los Angeles*

F. H. HAWKINS, Madison, Pillsbury & Sutro, Consultants, San Francisco, Calif. — *Oil Industry Viewpoint on Regulatory Picture*

NORMAN E. FAWLEY, Esso Standard Oil Company, Baltimore, Md. — *Air Pollution Control Measures at Baltimore Refinery*

IRON AND STEEL INDUSTRY SESSION—9:30 a.m. (concurrent)

F. S. MALLETTE, Executive Secretary, ASME Committee on Air Pollution Controls, Chairman;
H. M. CHAPMAN, Bethlehem Steel Company, Vice Chairman

ALLEN D. BRANDT, Bethlehem Steel Company, Bethlehem, Pa. — *Subject not yet given*

G. A. HOWELL, United States Steel Company, Pittsburgh, Pa. — *Air Pollution Control in the Steel Industry*

J. J. MUNN, Vice President, Weirton Steel Company, Weirton, W. Va. — *The Weirton Air Pollution Program*

J. H. SMITH, Technical Engineer, Kaiser Steel Corporation, Fontana, Calif. — *Sampling in Open Hearth Stacks*

Wednesday Afternoon, May 27

FUEL AND ITS RELATION TO THE AIR POLLUTION CONTROL PROGRAM—2 p.m.

CARROLL F. HARDY, Chief Engineer, Appalachian Coals, Inc., Chairman

CARROLL F. HARDY, Cincinnati, O. — *Availability of Good Coal in the United States*

GEORGE LAMB, Pittsburgh Consolidation Coal Company, Pittsburgh, Pa. — *Fuel Supply Outlook*

WILLIAM BRADBURY, Editor, *Utilization*, Washington, D. C. — *Mechanized Coal Mining and Cleaning and Their Effect on Reduction of Air Pollution*

NONFERROUS METAL INDUSTRY SESSION—2 p.m. (concurrent)

DR. L. V. CRALLEY, Aluminum Company of America, Pittsburgh, Pa., Chairman

L. V. OLSEN, American Smelting and Refining Co., Salt Lake City, Utah — *Subject not yet given*

R. E. MORKEN, Chrysler Highland Park Division, Detroit, Mich. — *Avoidance of Atmospheric Pollution in Reclamation of Oily Aluminum Turnings*

C. D. SCHMIDT, Cupola and Acc. Dept., Whiting Corporation, Chicago, Ill. — *Application of Bag Filters to Metallurgical Fumes*

C. C. LONG, R. E. LUND, K. F. PETERSON and G. A. JOHNSON, St. Joseph Lead Company, Monaca, Pa. — *Air Pollution Prevention at a Modern Zinc Smelter*

Wednesday Evening, May 27

BANQUET, FLOOR SHOW, AND DANCE

Thursday Morning, May 28

MUNICIPAL TRASH DISPOSAL AND INCINERATOR PERFORMANCE—9:30 a.m.

HARRY C. BALLMAN, Smoke Regulation Engineer, Columbus, O., Chairman

WILLIAM S. FOSTER, Engineering Editor, *The American City* — *Some Principles in Design and Operation of Modern Municipal Incinerators*

PAUL MACMURRAY, Commissioner of Streets, Philadelphia, Pa. — *Municipal Trash Disposal by Means of Controlled Open Dump Burning*

WILLIAM P. FANNON, Sanitary Engineer, Dept. of Public Works, Baltimore, Md. — *Municipal Incinerator Operation in Baltimore*

GORDON P. LARSON, Director of Air Pollution Control, Los Angeles County Air Pollution Control District — *Discharge from Incinerators*

METEOROLOGY AND STACK GAS DIFFUSION—9:30 a.m. (concurrent)

HENRY F. HEBLEY, Research Consultant, Pittsburgh Consolidation Coal Company, Pittsburgh, Pa., Chairman
W. F. DAVIDSON, Consolidated Edison Company, New York, N. Y., Co-Chairman

MAYNARD E. SMITH and IRVING A. SINGER, Brookhaven Laboratories, Long Island, N. Y. — *The Use of Averages in Air Pollution Meteorology*

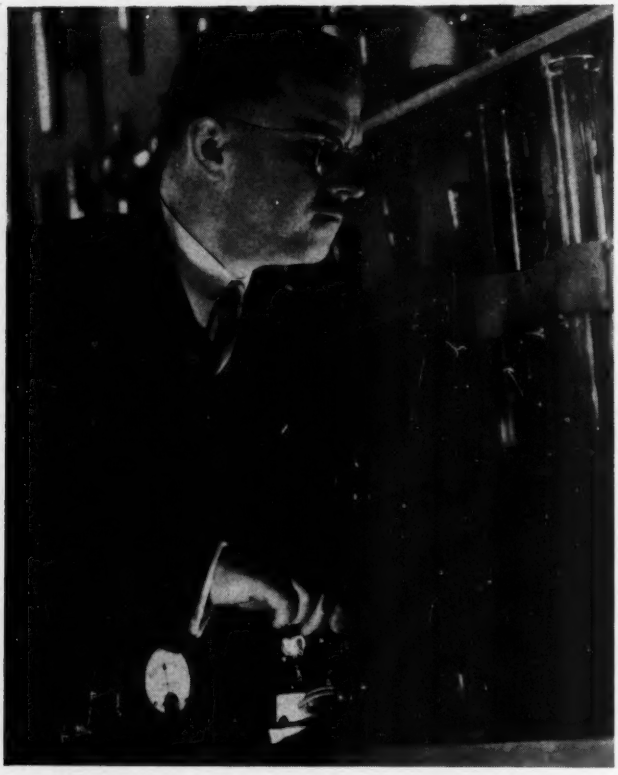
H. NEUBERGER, Pennsylvania State College, State College, Pa. — *The Vertical Distribution of Atmospheric Properties and Its Effect on Air Pollution*

H. VON HOHENLEITEN, Consolidated Gas Electric Light and Power Co., Baltimore, Md. — *Economic and Engineering Considerations in the Design of Stacks for Good Gas Dispersion*

W. N. MCDANIEL, Consolidated Gas Electric Light and Power Company, Baltimore, Md. — *Compensation for Gas Emission Velocity in Calculations of Stack Gas Dispersion*

Thursday Afternoon, May 28—2 p.m.

BUSINESS MEETING



Here Emerson Venable, author of the accompanying article, demonstrates the HCl relay, a gas detecting device which he invented. Consultant Venable lectured on chemistry, industrial hygiene, industrial engineering, and safety engineering at the University of Pittsburgh from 1937 to 1946. He is a member of a number of professional societies, and served as a consultant on chemical warfare to the U. S. Army Chemical Corps.

You And The Air You Breathe

by EMERSON VENABLE, *Consultant*

Pittsburgh, Pa.

ABOUT 100 MILLION years ago, probably somewhere in Central Asia, our early ancestor left the shelter of the trees to take up a precarious and new life on the growing plains and uplands.

The flowering of the human brain took place chiefly in the 20 million years following our ancestral descent from the top of the forest and in the last 100 million years our ancestral stem has not developed any new biological defense against the world about us. In our physical anatomy we have no more weapons against the sun, rain, heat, cold and dust than the little anthropoid who descended from the trees. In fact it is probable that we have left our early fur coat behind us and lack even that defense against the elements.

Through the amazing development of the brain we have become able to modify considerably our individual and social environment.

Change in the Air

Not the least of these environmental changes have been the changes in the air we breathe. For 140 million years the airborne dusts and mist particles have been low in number and relatively large in size. The noses of all air breathing animals have developed as dust traps adequate to the need. Now in less than one-millionth of that time the widespread use of fuels, the utilization of power machinery and chemical technology have increased atmospheric pollution many-fold. Into our air we pour increasing quantity of gases, mist, vapors and dusts of infiinite strangeness and variety. Mountain air may contain around 10 particles of dust per thimbleful. Urban and industrial areas may have many thousands of particles in the same volume.

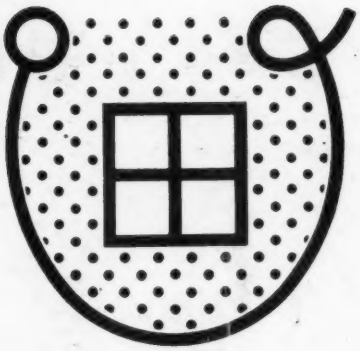
Harmful Substances Enter

Harmful substances can enter the body in a number of ways. Those which enter by mouth or are introduced into the throat through the nasal passages may cause local irritation in those areas. On entering the stomach they may be acted on by digestive fluids, enzymes and food, and pass on to be absorbed chiefly in the intestines. The major portion absorbed by the digestive system enters the portal blood circulation and passes to the liver before going to other organs. The liver is capable of removing many toxic materials from the blood, thus protecting the heart and central nervous system to some extent. This is the fate of dust particles which are caught in the dust and mist filter of the nose.

Finely divided dusts and mists, gases and vapors are not removed by our noses from the air we breathe. They pass into the lungs and from there directly into the blood stream. Arterial blood from the lungs goes directly to many vital organs without the protective mechanisms of stomach and liver.

The mechanism of absorption by the respiratory system is one of the most fascinating in physiology because of the elegance, efficiency and ease by which the tremendous quantities of air required to sustain life and activity are handled. Under heavy exertion breathing may be in the order of 2 to 3 cubic feet of air a minute (up to 85 liters or more per minute). At rest it may fall to a fraction of a liter per minute. To give some idea of the quantity of air you breathe consider a rate of say 22 liters per minute, a rate which is commonly used in developing respiratory apparatus.

We consume more air by weight than all our food and drink. An active child or adult can pass close to one-half his weight in air a day. Small wonder that air purity is as vital as water or food purity. If we reckon water purity in parts per ten million let us reckon atmospheric pollution likewise.

Much is being done to measure the atmospheric pollution we have created. Much is being done to determine its effects upon us. We have begun to control the soot from our fires. We must begin to control the sulfur from our stacks and the fly ash from our boilers.

The prize is not just the savings of cleaners' bills, the saving of the fantastic cost of corrosion and deterioration. It is the return to air which is a joy to breathe. It is the preservation of life, of health, of happiness. Who is happy in a smog?